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SUMMARY

NASA's Ice, Cloud, and land Elevation Satellite (ICESat) provided surface elevation measurements of the ice sheets from the launch in January 2003 until October 2009, resulting in a unique dataset for monitoring the changes of the cryosphere.
We have derived mean surface elevation changes of the Greenland Ice Sheet for the time span October 2003 – March 2008.

A distinct thinning of the ice sheet is found along the southeast and west coasts, and a smaller but consistent thickening is found in the interior part of the ice sheet. This is in agreement with previously published altimetry studies (e.g. Abdalati et al., 2001; Thomas et al., 2008; Pritchard et al., 2009).

The grid contains observed height changes of the Greenland Ice Sheet. The elevation changes observed by ICESat are not corrected for signals that are not related to the ice sheet mass balance (such as instrument bias, GIA and firn densification). Relevant corrections must be applied by the user.

MONARCH-A CONSORTIUM

Participant no.	Participant organisation name	Short name	Country
1 (Coordinator)	Nansen Environmental and Remote Sensing Center	NERSC	NO
2	The University of Sheffield	USFD	UK
3	Universität Hamburg	UHAM	NO
4	Centre National de la Recherche Scientifique	CNRS	FR
5	Scientific foundation Nansen International Environmental and Remote Sensing Center	NIERSC	RU
6	Universitetet i Bergen	UiB	NO
7	Danmarks Tekniske Universitet	DTU	DK
8	Institut Francais de Recherche pour l'Exploitation de la Mer	IFREMER	FR

Table of Contents

Table of Contents 6

1 Grid of ICESat height changes, average trend 2003-2008 7

1.1 Grid file 7

1.2 ICESat data 8

1.3 Method 8

1.4 Results 8

2 References 10

List of Figures

Figure 1: Grid of mean ICESat observed height changes 2003-2008. 7
Figure 2: Derived surface elevation changes in the ICESat tracks, 2003-2008. 9

1 Grid of ICESat height changes, average trend 2003-2008

1.1 Grid file

Grid of ICESat height changes, average trend 2003-2008.

The grid contains observed height changes of the Greenland Ice Sheet. The elevation changes observed by ICESat are not corrected for signals not related to the ice sheet mass balance (such as instrument bias, GIA and firn densification). Such corrections must be applied by the user.

The height change grid is provided in the file: dHdt_ICESat_2003-2008.txt

Available at: ftp://ftp.spacecenter.dk/pub/MONARCH-A/D.2.3.2/

File format: lon, lat, dH/dt [m/yr]

The resolution of the grid is 5 km x 5km, and is adapted from:
http://websrv.cs.umt.edu/isis/index.php/Present_Day_Greenland

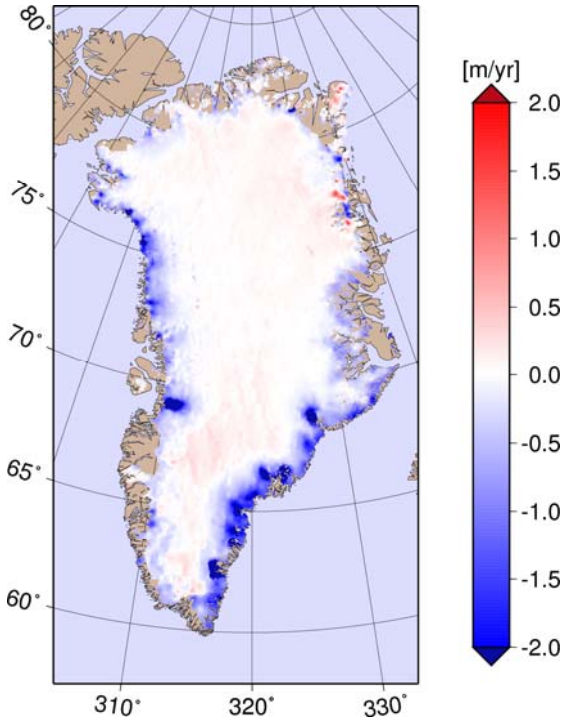

Figure 1: Grid of mean ICESat observed height changes 2003-2008.

1.2 ICESat data

The GLAS/ICESat Antarctic and Greenland Ice Sheet Altimetry Data product (GLA12) (Zwally et al., 2010) was downloaded from the National Snow and Ice Data Center.

This level-2 altimetry product provides geolocated and time tagged ice sheet surface elevation estimates, with respect to the TOPEX/Poseidon reference ellipsoid. The satellite laser footprint size is 30–70m and the distance between the footprint centres is approximately 170 m. This study is based on the 91-day repeat cycle ICESat data (release 31) from October 2003 to March 2008.

A procedure of data culling and the application of corrections is necessary to reduce some of the systematic errors in the ICESat dataset and to remove problematic measurements (Smith et al., 2005). The data culling procedure applied here, is described in sect. 2 of (Sørensen et. al., 2011).

1.3 Method

The method for deriving the elevation change grid is presented in Sørensen et al., 2011. The method M3 is applied (sect. 3.3 of Sørensen et al., 2011).

The ICESat tracks are divided into along-track segments of 500 m in size. In each of these segments we solve for dH/dt by least squares fitting of rigid planes. We assume that the surface elevation (H) varies linearly with position, time and a seasonal signal. The same procedure is used at track cross over locations.

The dH/dt estimates are interpolated onto the 5×5 km grid by ordinary kriging. An exponential variogram model with a range of 50 km is used. The variogram model is based on all data. The range and the choice of model are based on the experimental variogram. Cross-validation analysis is applied to determine the sufficient number of the closest points to be used in the interpolation. The R package gstat is used for the kriging procedure (Pebesma, 2004).

1.4 Results

A distinct thinning of the ice sheet is found along the southeast and west coasts, and a smaller but consistent thickening is found in the interior part of the ice sheet. This is in agreement with previously published altimetry studies (e.g. Abdalati et al., 2001; Thomas et al., 2008; Pritchard et al., 2009).

On a more local scale, the thickening of Flade Isblink (81.4 N, 15.1 W) and Storstrømmen (77.1 N, 22.6 W) is clearly seen.

By fitting a smooth surface through the observed dH/dt values, by the kriging procedure described above, we obtain a volume change estimate of -239±26 km^3/yr for the period 2003-2008.

The error estimate of the volume change is estimated using a bootstrap procedure which is performed on the ICEsat tracks (sect. 4.2 of Sørensen et al., 2011) (Davison and Hinkley, 2006).

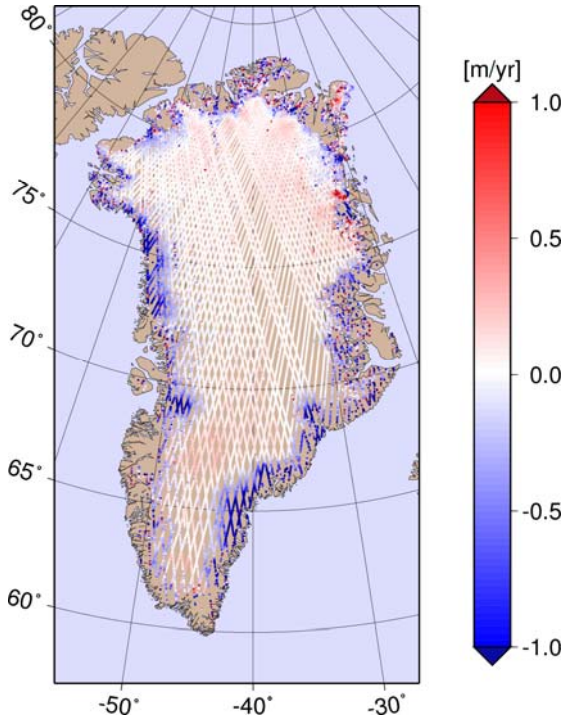

Figure 2: Derived surface elevation changes in the ICESat tracks, 2003-2008.

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